**1. Laser. (20%)**

Explain how these lasers work. (1) Ne-He laser; (2) Ruby laser; and (3) Diode laser.

**2. Laser safety. (20%)**

A CO2 laser (=10.6 m) with a power of 60 watts is projected onto a dilated human eye pupil of 6 mm diameter. The eye is exposed for a duration of 10 seconds. Calculate the minimum optical density OD of a laser safety goggle needed to protect the eye from damage.

**3. Optical sensor (PMT). (20%)**

A PMT with 11 dynodes, with single dynode gain d =6, quantum efficiency is 25%. Yellow light (550 nm) strikes the photocathode and generate anode current 5 A. Calculate the incident light power.

Ans:

%---------------------------------------------------------------------

% file name : hmwk\_3\_prob\_3\_opitcal\_sensor.m

% Student: Ray Duran

% Date: 3/21/22

% Class : BME 690 Professor Liang, Spring Semester

% University of North Dakota

% Descr:

% Optical Sensor PMT

%---------------------------------------------------------------------

qe = .25; % quantum efficiency

% All of this is electrons / sec

I = 5e-6;% C/S

electrons = I\*6.24e18; % C\* electrons/C

photons = electrons/qe; % Photons at photocathode?

E = (3e8)\*(6.62607015e-34)/(550e-9); % Joules one photon h\*c/lambda

total\_energy = photons\*E;

% And since this is all in one second

power = total\_energy;

Total enery = 4.5105e-5 W

**5. Polarization (20%)**

Use calcite to make a quarter-wave plate (designed for light =590 nm). (1) What is the minimum thickness of this quarter-wave plate? (2) If a right-hand circular polarized light passes through this wave plate, what is the polarization state of the emerging light? Use Jones matrix method to calculate and explain it.

Ans:

%---------------------------------------------------------------------

% file name : hmwk\_3\_prob\_5\_polarization.m

% Student: Ray Duran

% Date: 3/22/22

% Class : BME 690 Professor Liang, Spring Semester

% University of North Dakota

% Descr:

% Polarization

%---------------------------------------------------------------------

lambda = 590e-9; % wavelength

% Use values from lecture where lambda = 589.3 nm

% for approx. lambda = 590 nm

ne = 1.4864; % for Ey

no = 1.6584; % for Ex

d = lambda/(4\*(abs(ne-no))); % for a quarter wave plate

% If RHCP light passes thru above wave plate

% nx > ny

AQWP = [ 1 0; 0 1i];

%RHCP light

rhcp\_light = (1/sqrt(2)).\*[ 1; -1i];

Emerge\_light\_polarization = AQWP\*rhcp\_light;

Ans part a:

So, d = .85756 um

Ans part b:

Emerging light is 1/sqrt(2) [ 1; 1;]

This means that the RHCP light was rotated into linear 45 degree polarized light.